

Madden-Julian Oscillation: Recent Evolution, Current Status and Predictions



Update prepared by the Climate Prediction Center
NWS / NCEP / CPC
16 October 2023

Overview

- While the MJO showed signs of some renewed activity since early October, the intraseasonal signal has since become much less coherent, as low frequency variability appears to be playing a more dominant role in the global tropics.
- In addition to the ongoing El Niño conditions, there is also a clear atmospheric response to a strengthening positive Indian Ocean Dipole (+IOD) event. Both of these stationary modes of variability are likely to stymie any reorganizing MJO activity during the outlook period.
- Another equatorial westerly wind burst event that is forecast mainly west of the Date Line is likely to reinforce the El Niño response, as well as increase chances for tropical cyclone formation on both sides of the equator over the western Pacific in the near-term.
- Anomalous upper-level divergence aloft associated with remnant MJO activity over the Western Hemisphere and Africa, as well as the potential development of a Central American Gyre (CAG) increases chances for tropical cyclone development over the eastern Pacific and the Caribbean.

A discussion of potential impacts for the global tropics and those related to the U.S. are updated on Tuesday at:

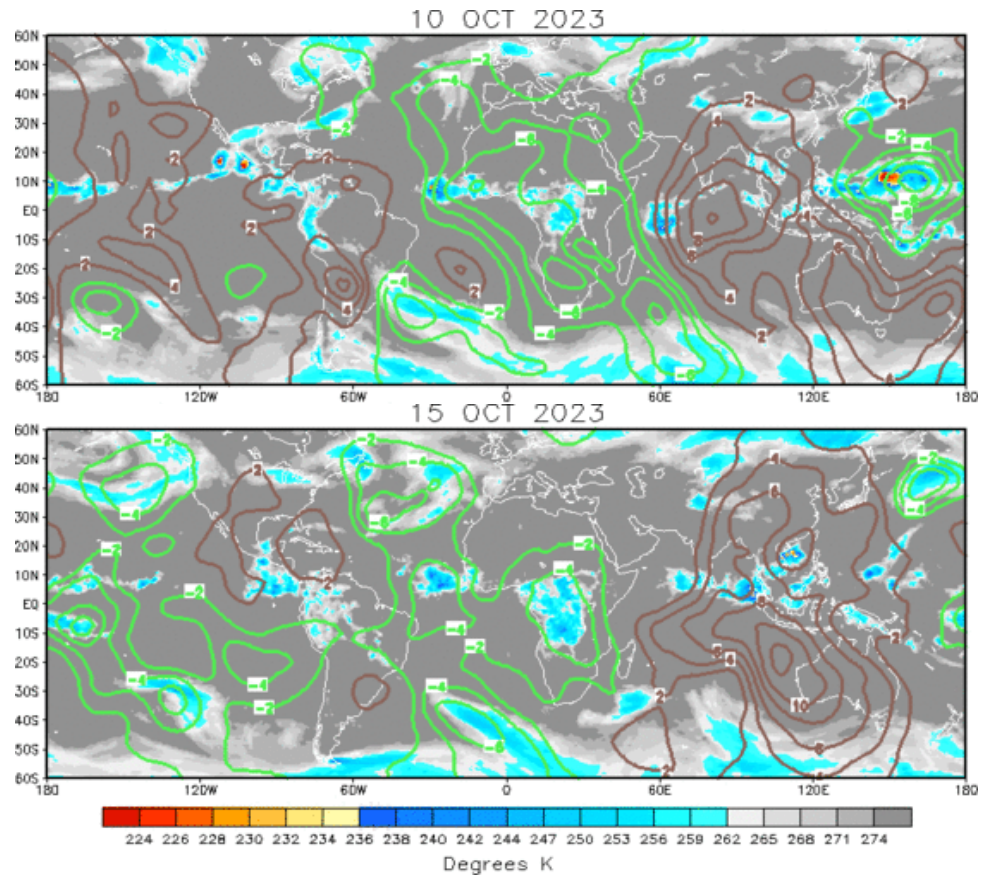
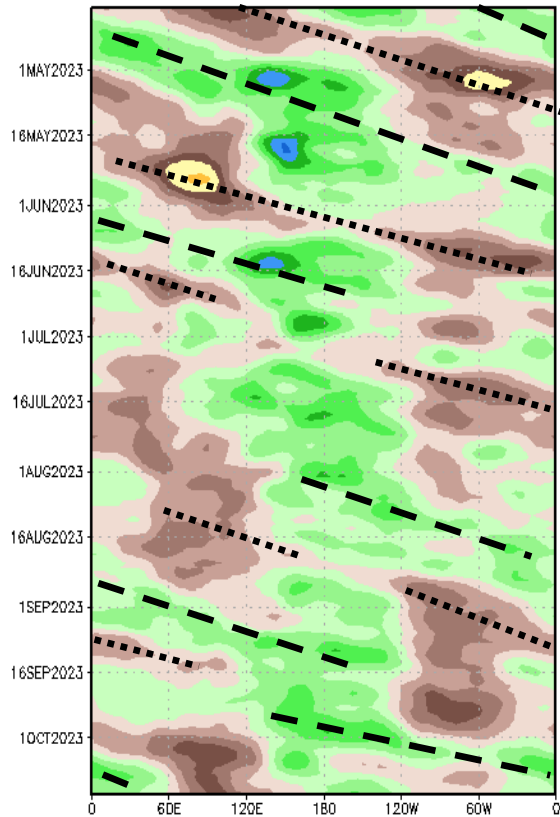
<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

200-hPa Velocity Potential Anomalies

Green shades: Anomalous divergence (favorable for precipitation)

Brown shades: Anomalous convergence (unfavorable for precipitation)

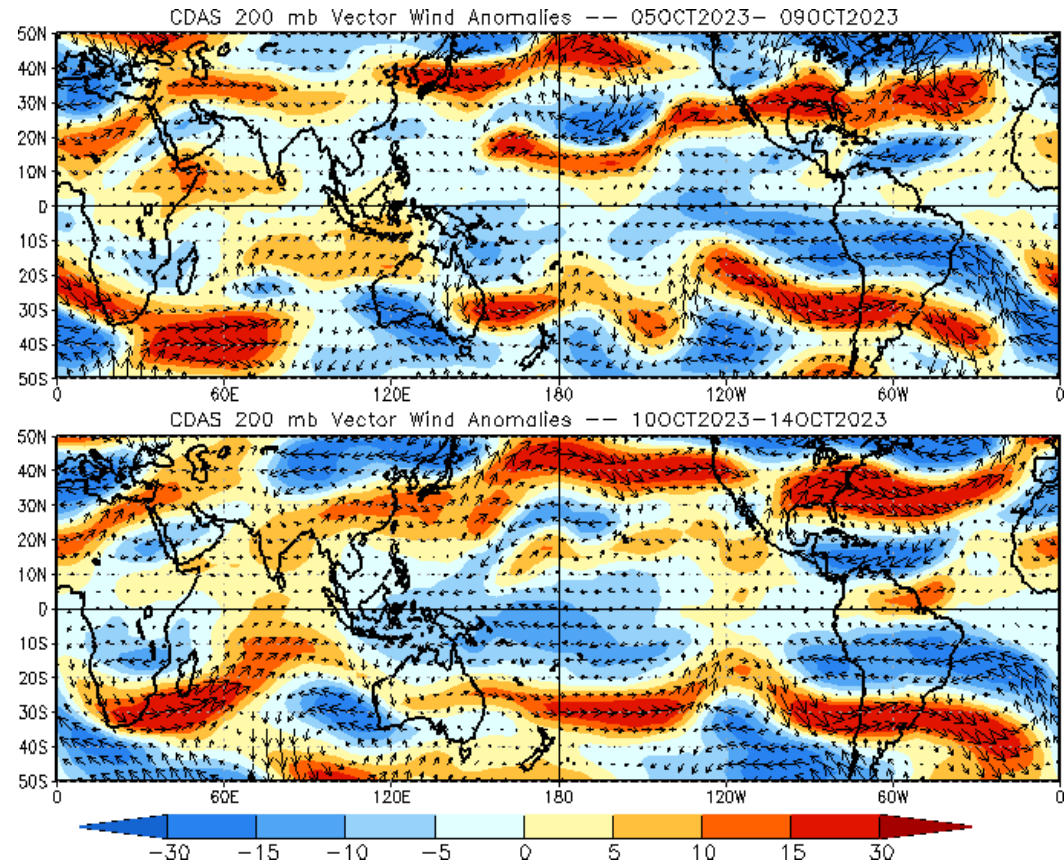
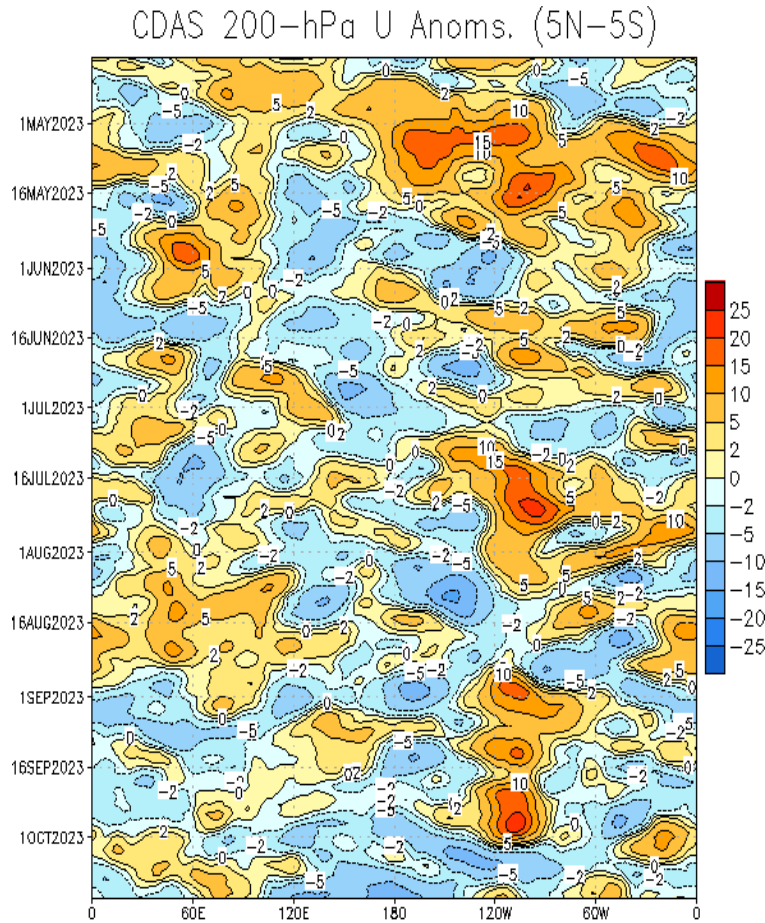
200-hPa Velocity Potential Anomaly: 5N-5S
5-day Running Mean



- The upper-level velocity potential anomaly pattern has become more incoherent in the past week, depicting more of a wave-2 pattern more recently.
- In addition to the low frequency El Niño footprint over the equatorial Pacific, strongly suppressed conditions remain entrenched between 60E and 120E, which is likely tied to a strengthening positive Indian Ocean Dipole (+IOD) event in the basin.
- There has been little to no eastward propagation of the enhanced intraseasonal envelope.

200-hPa Wind Anomalies

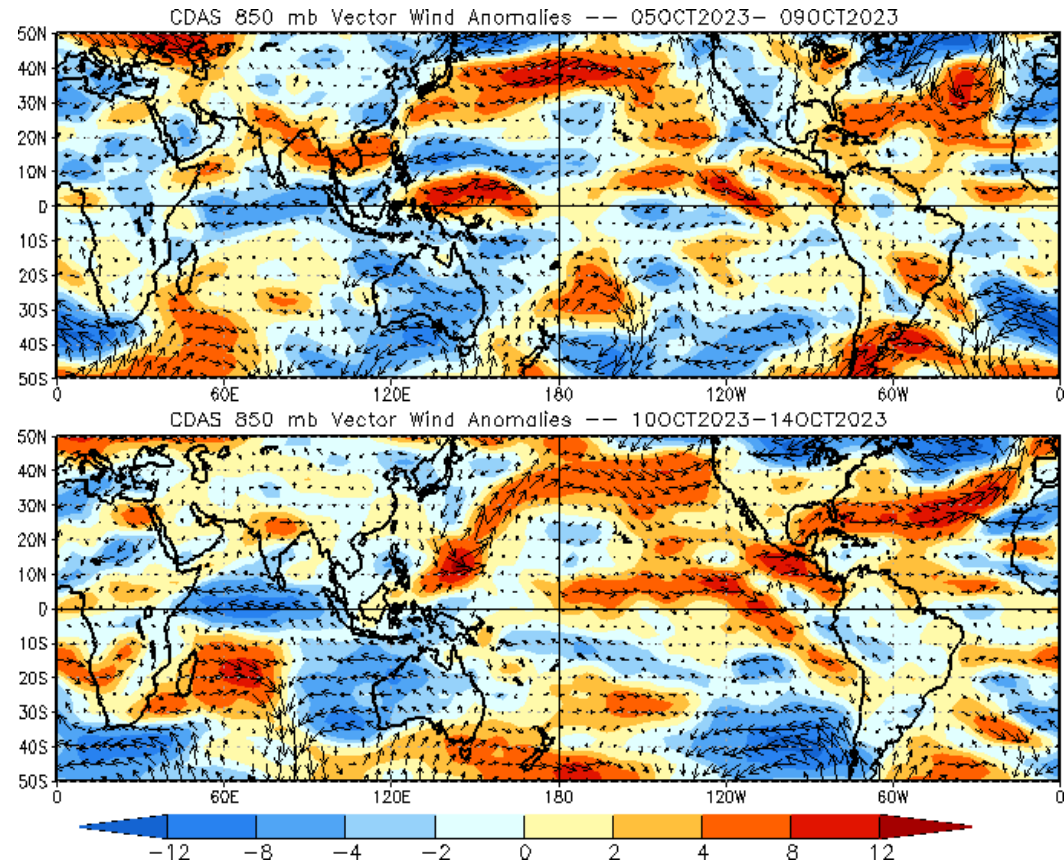
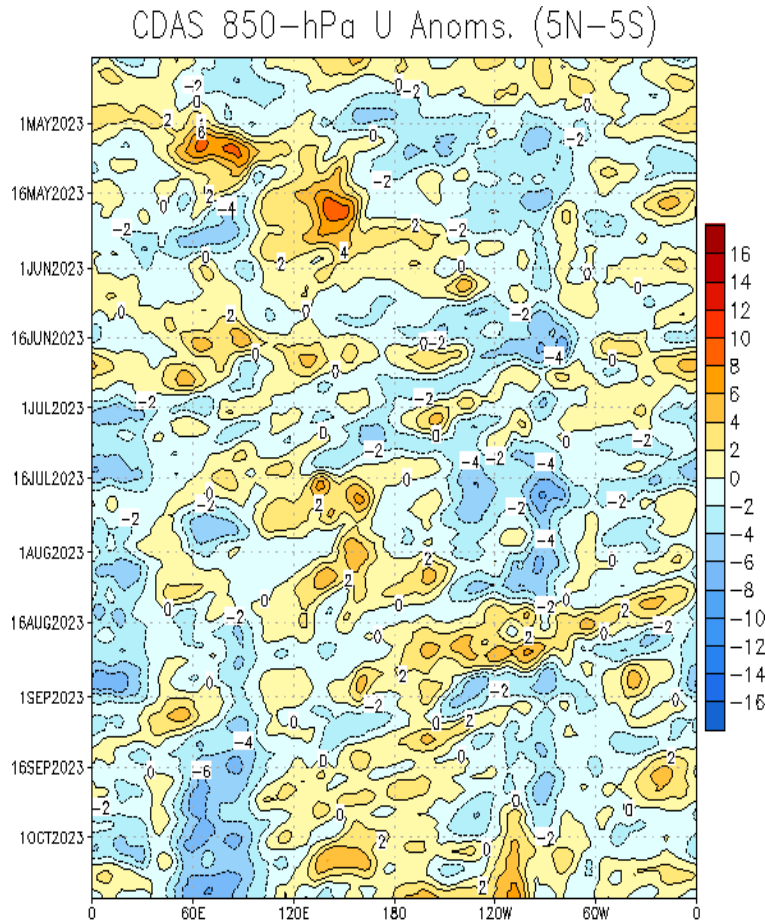
Shading denotes the zonal wind anomaly. **Blue shades: Anomalous easterlies.** **Red shades: Anomalous westerlies.**



- An active subtropical jet persists over the northeastern Pacific into the southern tier of the CONUS, with anomalous easterlies reemerging across the equatorial Pacific, both consistent with an atmospheric response to El Niño conditions.
- Anomalous upper-level westerlies strengthened along and to the south of the Equator over the Indian Ocean.

850-hPa Wind Anomalies

Shading denotes the zonal wind anomaly. **Blue shades:** Anomalous easterlies. **Red shades:** Anomalous westerlies.

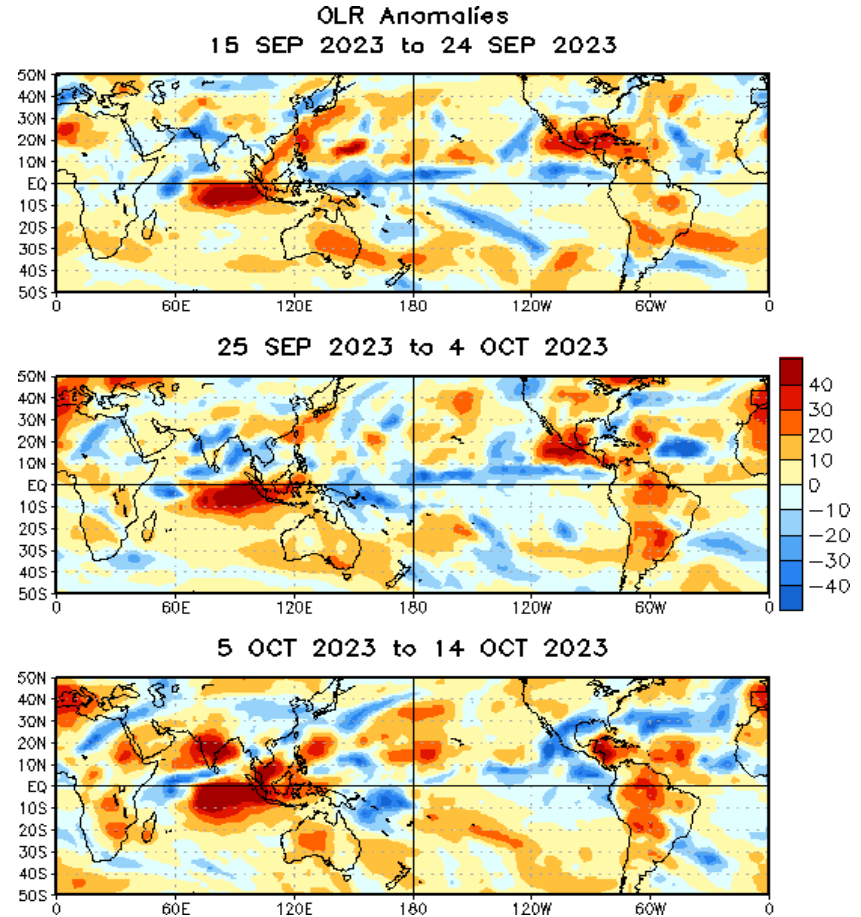
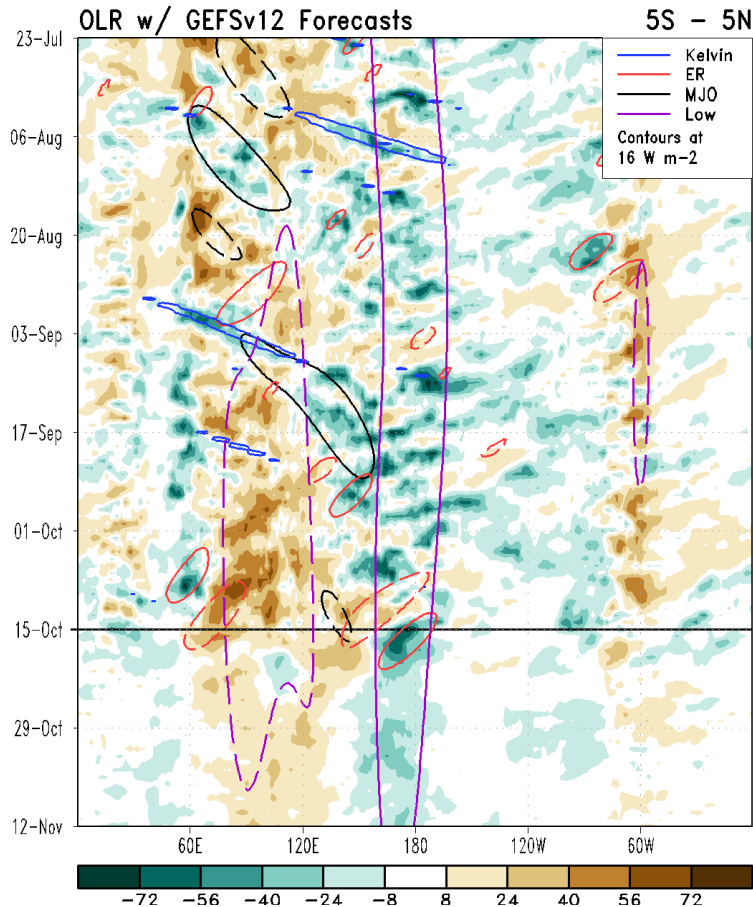


- Strong low-level easterlies remain established over the equatorial Indian Ocean, while trades remained relaxed over the equatorial Pacific along and north of the equator.
- Following an uptick in the amplitude of the MJO over the western Hemisphere, anomalous westerlies became more prevalent over equatorial Africa, as well as the tropical eastern Pacific and Atlantic, favorable for tropical cyclone development.

Outgoing Longwave Radiation (OLR) Anomalies

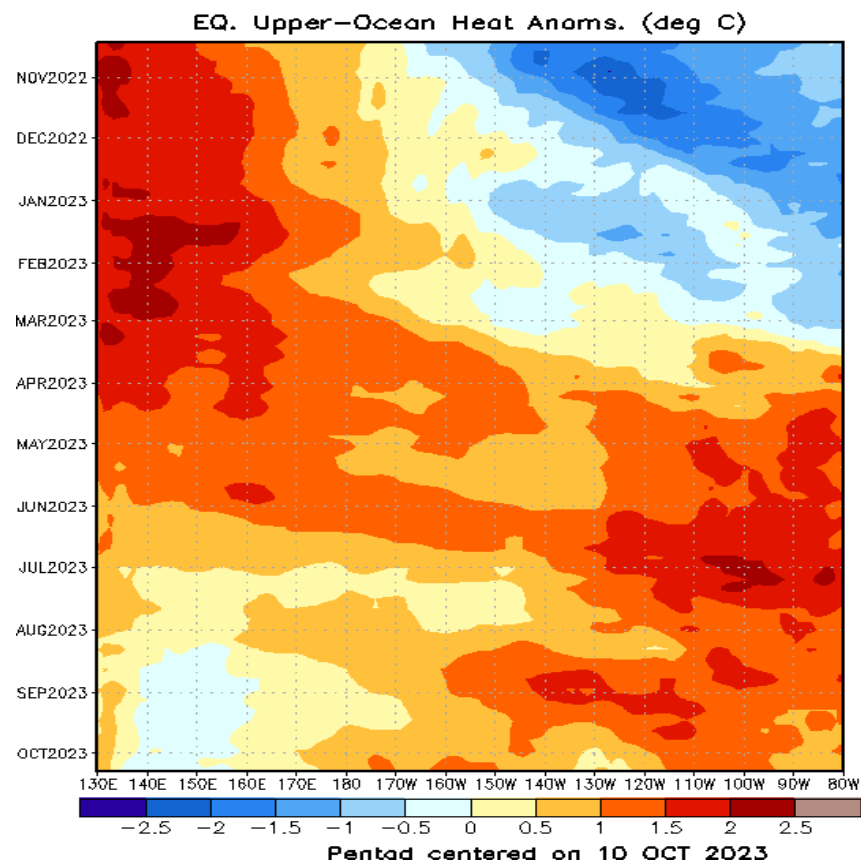
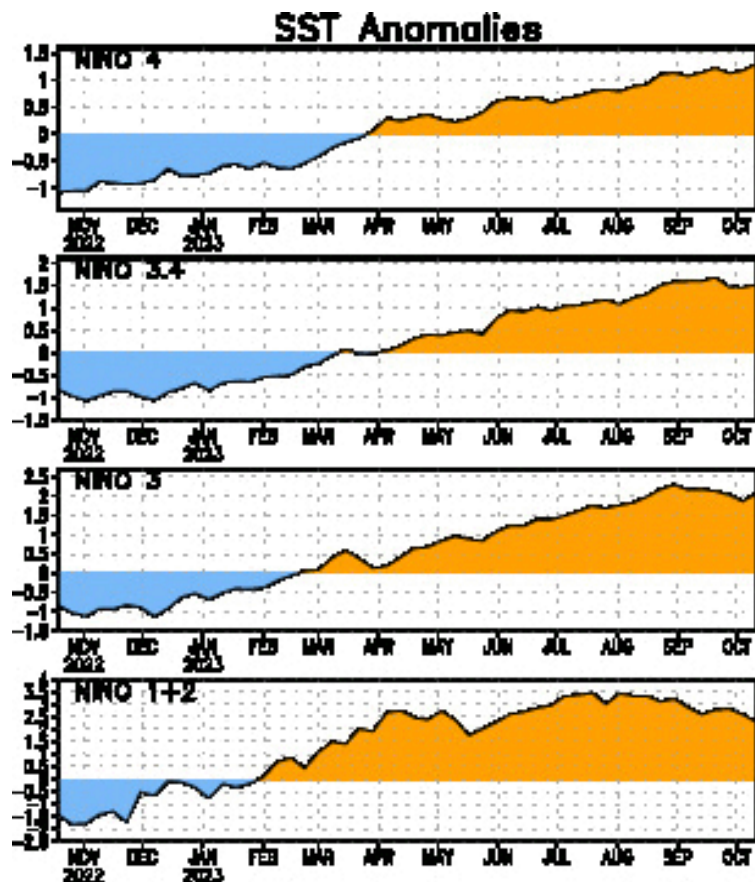
Green shades: Anomalous convection (wetness)

Brown shades: Anomalous subsidence (dryness)



- Objective filtering of OLR anomalies indicates low frequency variability is dominating the convective pattern across the global tropics.
- OLR anomaly maps show much of the suppressed convection over the Indian Ocean and Maritime expanding in coverage with time.
- OLR forecasts show little change to this regime, though some weakening is favored within the suppressed low frequency footprint.

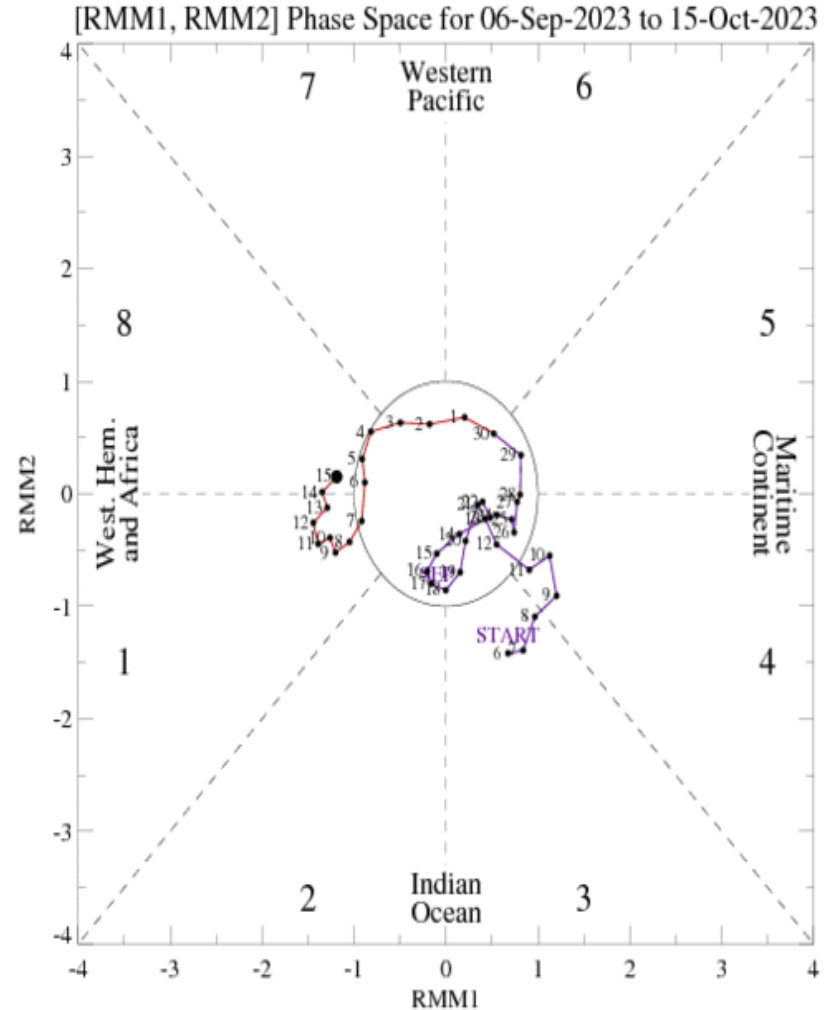
SSTs and Weekly Heat Content Evolution in the Equatorial Pacific



- El Niño conditions are present across the equatorial Pacific with SST anomalies remaining strongly positive in all of the Niño basins.
- A resurgence of positive heat content anomalies is observed across the central Pacific. These warm subsurface waters are likely to be reinforced by additional oceanic downwelling Kelvin wave activity triggered by a westerly wind event observed recently, and another event forecast in the western Pacific.

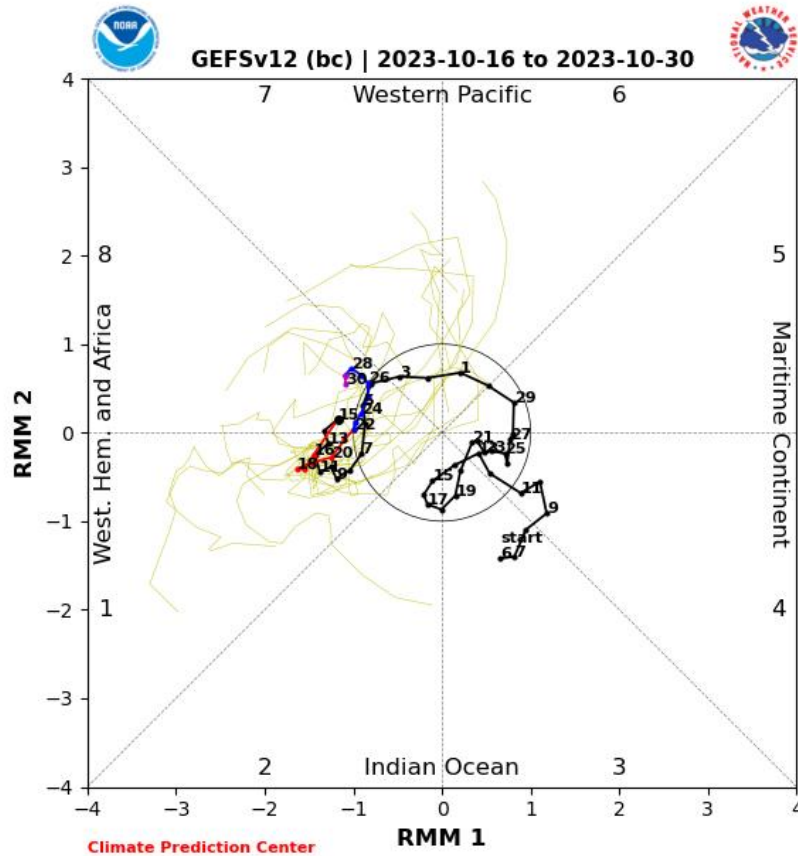
MJO Index: Recent Evolution

- Since early October, the RMM index shows the MJO signal propagating across the western Pacific, while increasing in amplitude over the western Hemisphere. However, the signal has since retreated westward suggestive of competing variability in the tropics.

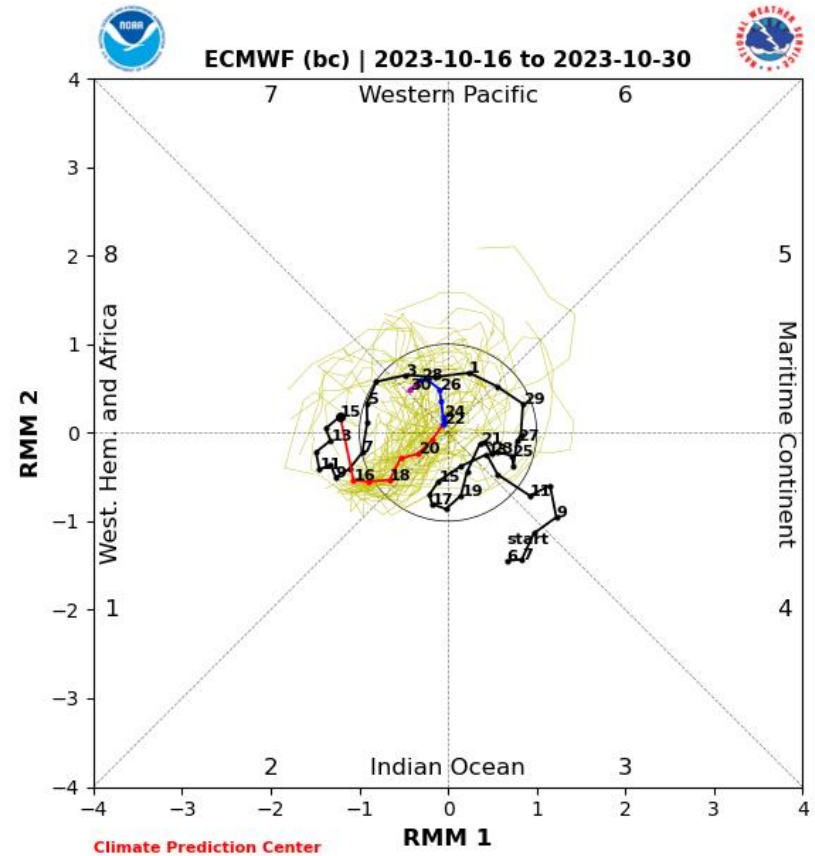


For more information on the RMM index and how to interpret its forecast please see:
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CPC_MJOinformation.pdf

MJO Index: Forecast Evolution



GEFS Forecast



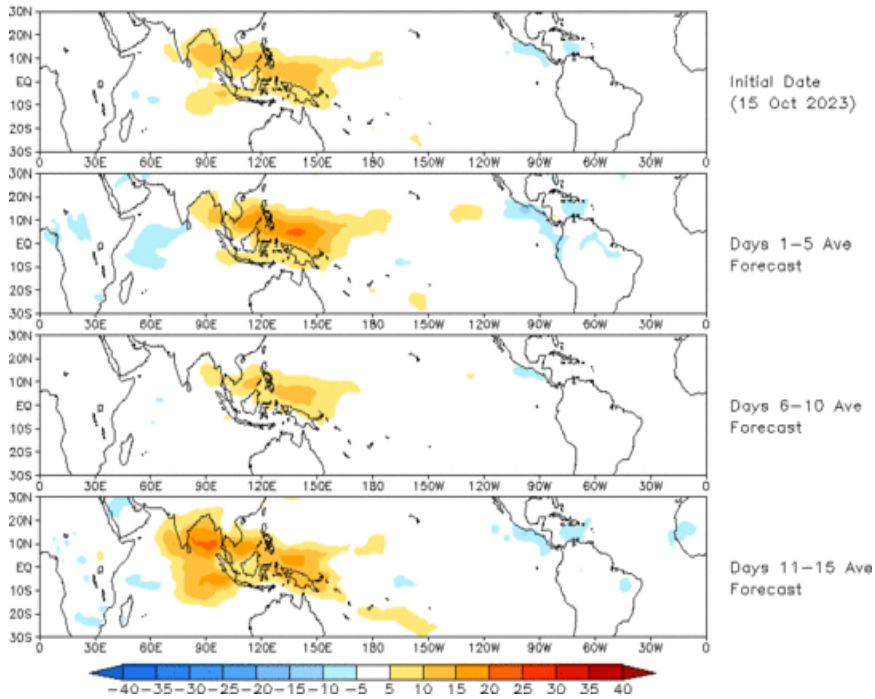
ECMWF Forecast

- RMM forecasts generally favor a brief resumption of an eastward propagating MJO signal, followed by a loss in amplitude while retreating westward. The westward shifting behavior may be related to a strong westerly wind event favored in the dynamical models along and to the east of the Date Line.
- The addition of a secondary stationary signal emerging in the tropics (+IOD) poses questions as to how well the RMM index will be able to present intraseasonal activity moving forward.

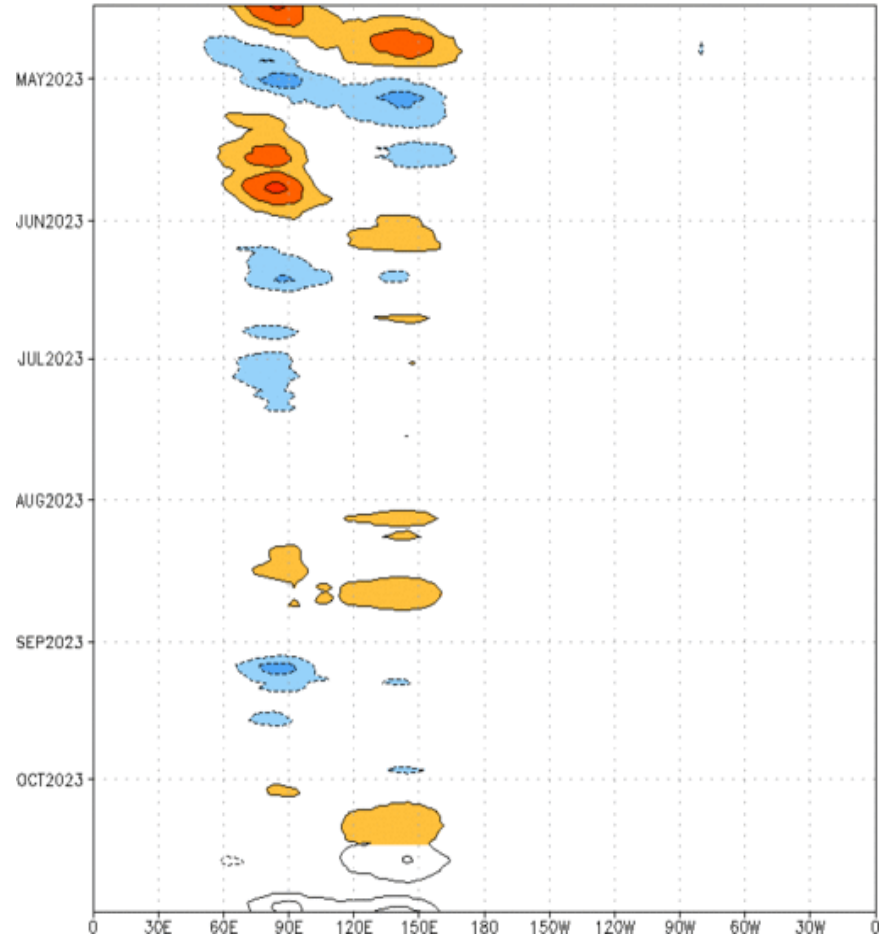
MJO: GEFS Forecast Evolution

Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

Prediction of MJO-related anomalies using GEFS operational forecast
Initial date: 15 Oct 2023
OLR



Reconstructed anomaly field associated with the MJO using RMM1 & RMM2
OLR [$7.5^{\circ}\text{S}, 7.5^{\circ}\text{N}$] ($\text{cont: } 4\text{Wm}^{-2}$) Period: 15-Apr-2023 to 15-Oct-2023
The unfilled contours are GEFS forecast reconstructed anomaly for 15 days

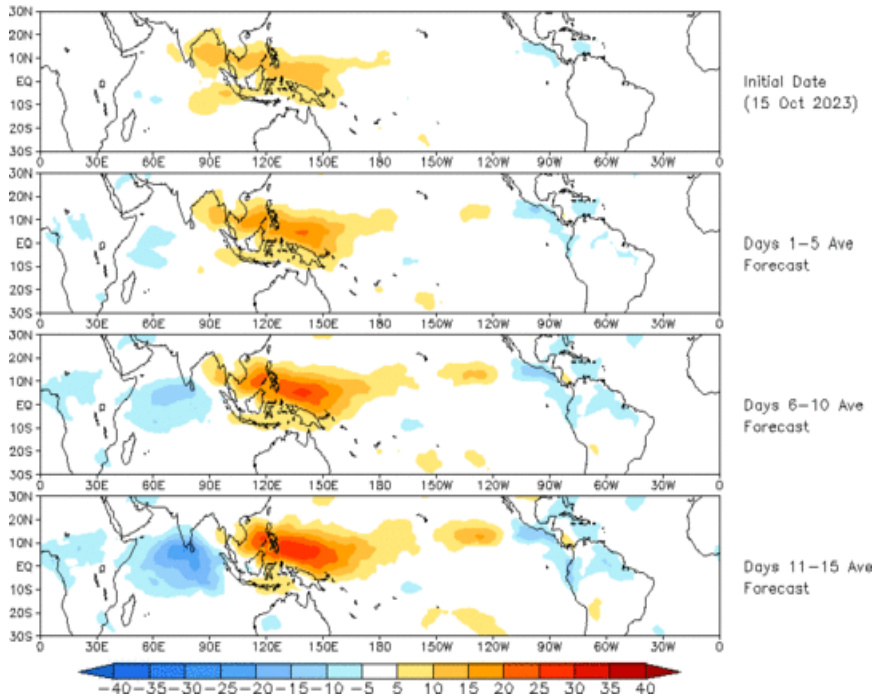


- The GEFS RMM-based OLR forecast depicts a slightly progressive convective signal, but becomes dominated by suppressed convection from the Indian Ocean to the western Pacific later in October.

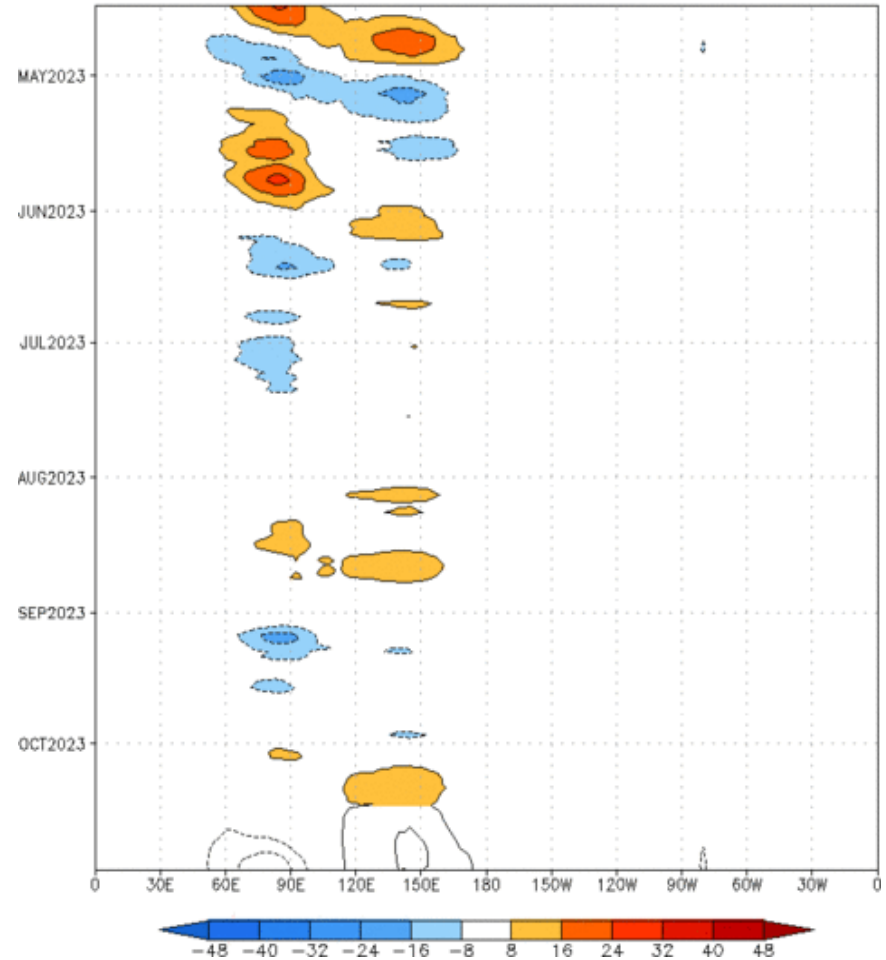
MJO: Constructed Analog Forecast Evolution

Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons, etc.)

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (15 Oct 2023)



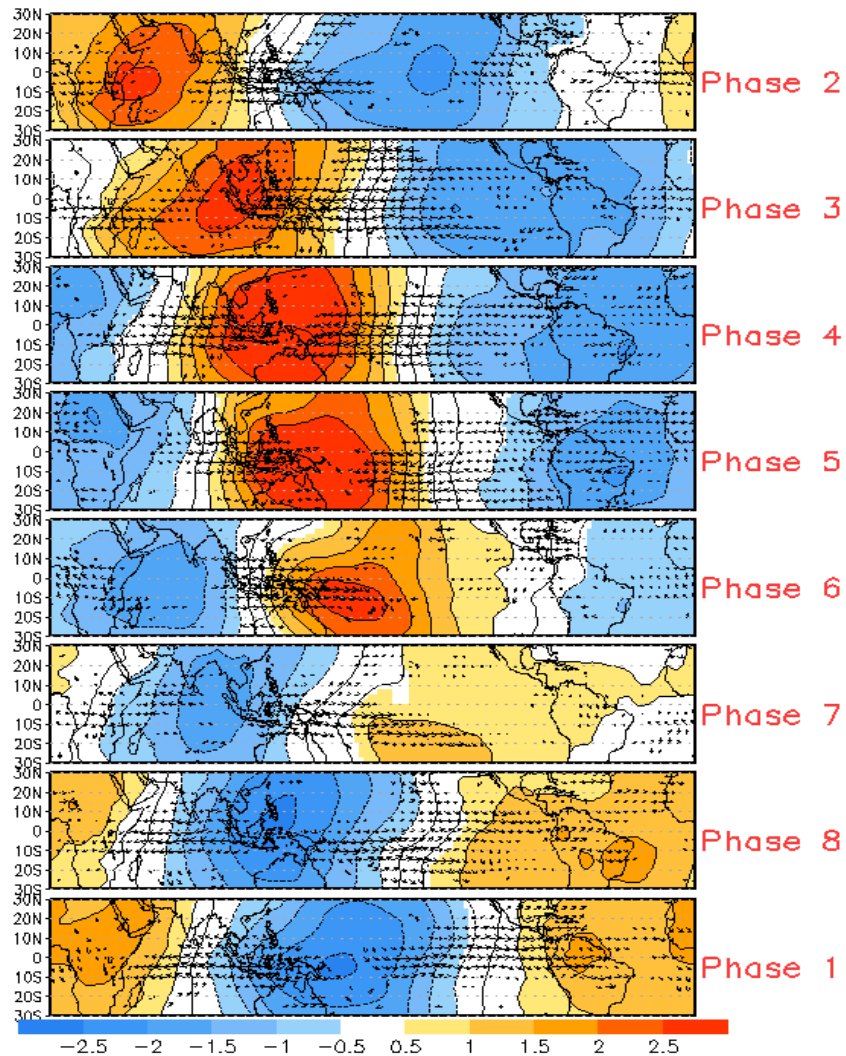
Reconstructed anomaly field associated with the MJO using RMM1 & RMM2 OLR [7.5°S,7.5°N] (cint:4Wm⁻²) Period:15-Apr-2023 to 15-Oct-2023
The unfilled contours are CA forecast reconstructed anomaly for 15 days



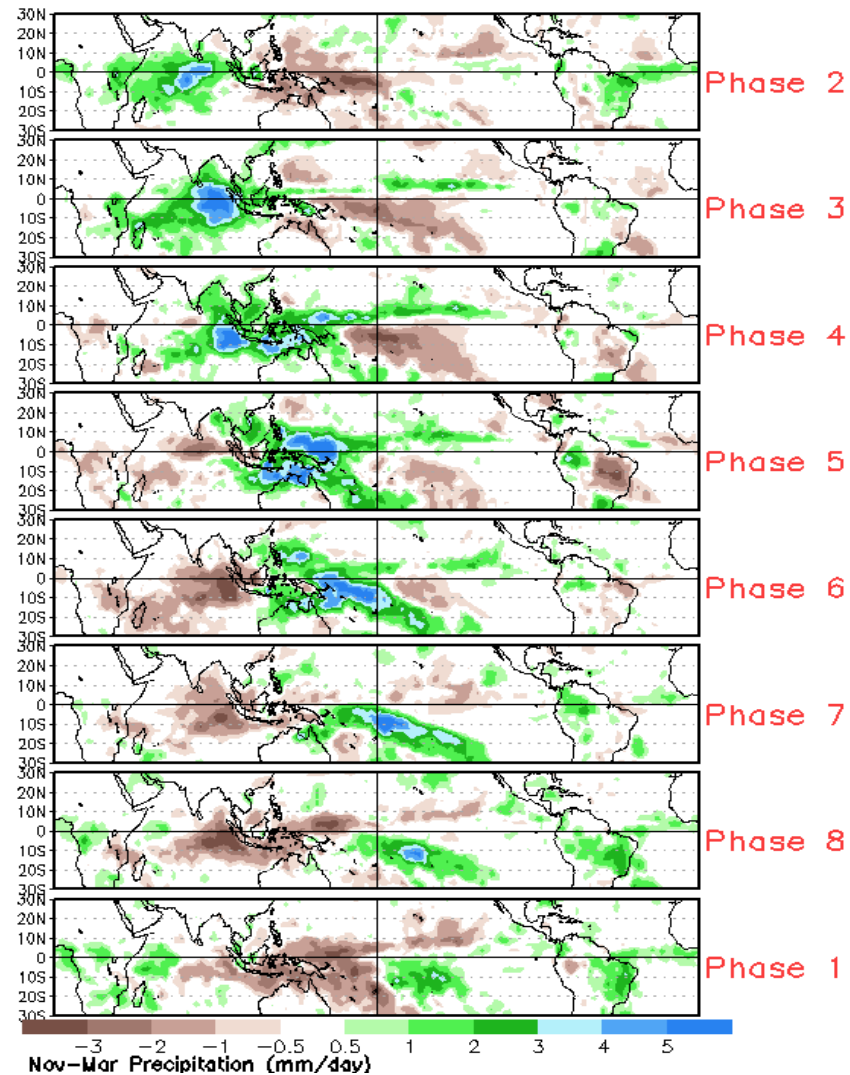
- The constructed analog RMM-based forecast reflects a more canonical Indian Ocean MJO event.

MJO: Tropical Composite Maps by RMM Phase

850-hPa Velocity Potential and Wind Anomalies



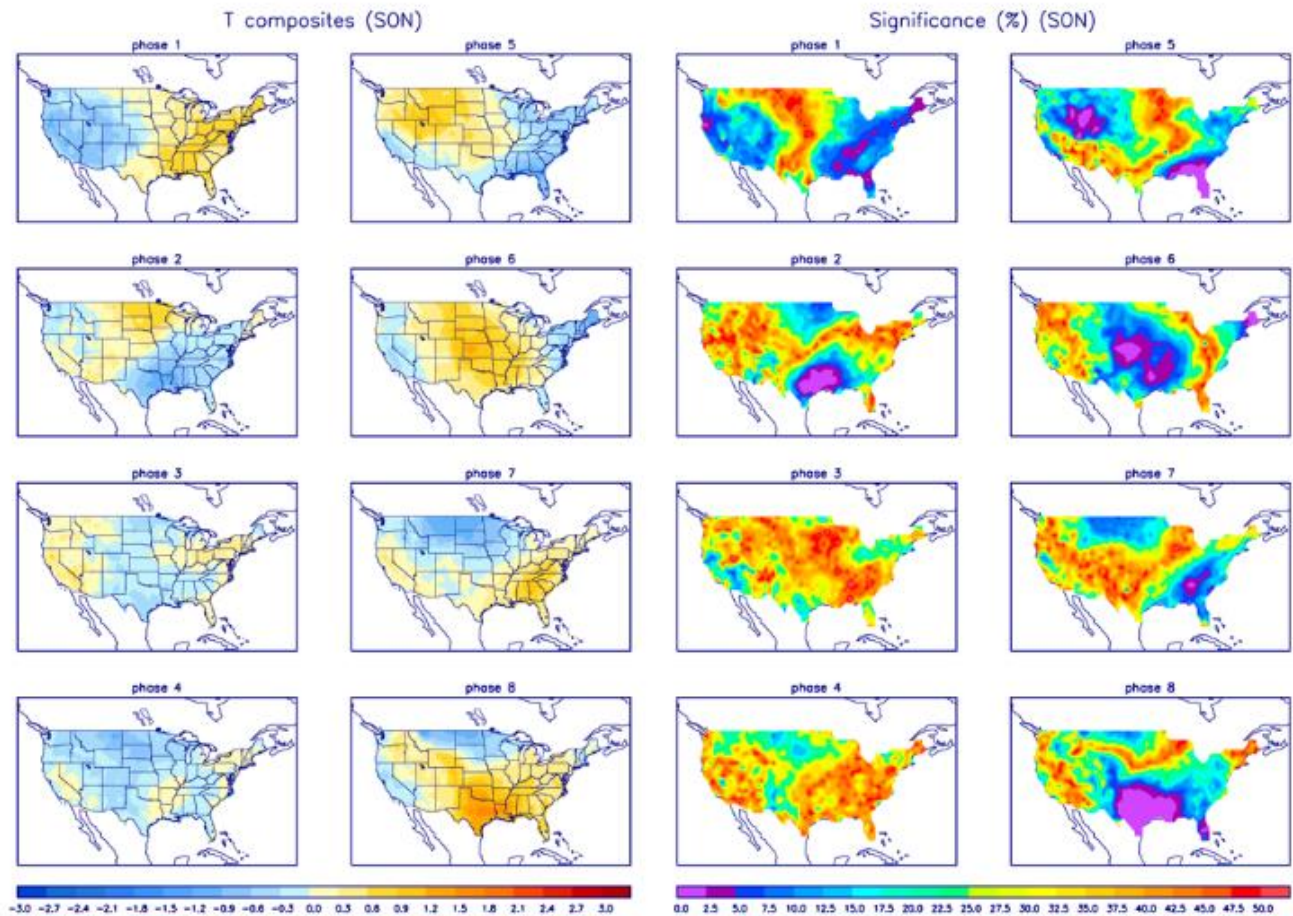
Precipitation Anomalies



MJO: CONUS Composite Maps by RMM Phase - Temperature

Left hand side plots show temperature anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Blue (red) shades show negative (positive) anomalies respectively.

Right hand side plots show a measure of significance for the left hand side anomalies. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.



MJO: CONUS Composite Maps by RMM Phase - Precipitation

Left hand side plots show precipitation anomalies by MJO phase for MJO events that have occurred over the three month period in the historical record. Brown (green) shades show negative (positive) anomalies respectively.

Right hand side plots show a measure of significance for the left hand side anomalies. Purple shades indicate areas in which the anomalies are significant at the 95% or better confidence level.

